Safety Science 99 (2017) 1–4

Contents lists available at ScienceDirect

Safety Science

journal homepage: www.elsevier.com/locate/safety

Editorial: Learning from Incidents

1. Introduction to learning from incidents

Industrial incidents cause injury, loss of life, loss of equipment, productivity, reputations and environmental degradation. Organisations spend large sums of money on improving safety, yet major accidents still occur. Recent major incidents include Santiago de Compostela train derailment (2013), the Fukushima Nuclear Accident in Japan (2011) and the Deepwater Horizon oil spill in the Gulf of Mexico (2010). Incident investigations have identified a common factor: the inability of organisations to learn from incidents (Cooke and Rohleder, 2006; Turner, 1978). Effective learning from incidents (LFI) is, therefore, critical for worker safety, organization survival and environmental protection (Lindberg et al, 2010).

Yet little is known about what constitutes 'effective' LFI and how to achieve it. LFI initiatives have largely focused on the dissemination of information (Cooke and Rohleder, 2006), e.g., through safety-related circulars. The premise is that making incident-related information available to workers brings about the learning and behavioural changes required to improve safety. Yet research in adult learning shows that access to information does not necessarily lead to learning and collective behavioural change (Smith and Defrates-Densch, 2008). Learning requires opportunities for reflection and sensemaking (Sanne, 2008), yet LFI initiatives seldom integrate these (Gherardi and Nicolini, 2000; Gordon, 2008; Macrae, 2008). There is an urgent need to reconceptualise LFI, moving beyond the 'learning as information acquisition' paradigm, towards learning as collective sensemaking, reflection on, and change in, practice and continuous knowledge flow in organistions.

Such reconceptualization requires grounding in comprehensive research. Historically, research in LFI has been limited to the field of Safety Science, rooted in Engineering. A key limitation of past LFI research is that it has largely been reductionist and techno-centric in approach. Typically, it has focused on failures of production processes or technological system whilst missing the complexity of sociotechnical systems (Walker et al, 2008; Salmon et al, 2011). To address this limitation, Human Factors research has examined human social and psychological interaction with technological systems (Salmon et al, 2013; Stanton and Walker, 2011; Stanton and Harvey, 2017; Walker et al, 2017). Even so, this approach does not draw on related social sciences research into Adult and Organisational Learning and Sociology (Lukic et al, 2010). Similarly, methodological approaches have been limited to the quantitative paradigm, producing decontextualized results. The potential of qualitative, in particular ethnographic methods (Buescher et al, 2009; Plant and Stanton, 2012), to provide more holistic insight is largely unexplored. Finally, LFI has suffered from lack of integration of research findings, resulting in disciplinary fragmentation of the field.

The purpose of this special issue is to bring LFI to the attention of researchers around the world to stimulate research in this topic area. We argue that interdisciplinary research and methodological pluralism are critical for improving the understanding of LFI. The special issue aims to deliver a much-needed interdisciplinary research agenda including, but not limited to, Adult and Organisational Learning, Computer Science, Engineering, Ethnography, Human Factors, Industrial Psychology, Sociotechnical Systems, and Sociology. The papers in this special issue are divided into two main sections. This first is focused on the investigating and analysing incidents. The second is focused in tools and design for learning from incidents. Before those sections are presented, is an overview of the research and development agenda for LFI.

Margaryan, Littlejohn and Stanton (research and development agenda for LFI), present an overview and strategy for LFI. They argue that the weakness in organisational learning from incidents is due to the majority of the focus being on the investigatory process and generation of recommendations rather than on the implementation of changes. There is a perceived lack of balance in ensuring that the recommendations are implemented at all levels in the organization, from the board room, through levels of management, to the shop floor. Margaryan et al argue that part of the problem is due to a poor understanding of human learning, which needs to be incorporated into a mixed methods approach. They point out that LFI requires an integrated, multidisciplinary, approach (as indicated above). Strategies for enhancing the learning in LFI are proposed (many of which are represented in the papers in this Special Issue). Margaryan et al conclude that there are four main challenges facing LFI, which need to be resolved for progress to be made. These include: integrating the interdisciplinary LFI perspectives, taking a systems-based approach to LFI, development of LFI indicators and metrics, and bridging the LFI research-practice divide. The papers presented in the following two sections are already addressing these challenges.

2. Investigating and analysing incidents

Five of the papers in the special issue are associated with investigating and analysing incidents. Walker considers how to redefine the incidents to learn from, drawing on safety science insights acquired on the journey from black boxes to flight data monitoring. Plant and Stanton discuss the development of the schema-action-world (SAW) taxonomy for understanding decision making in aeronautical critical incidents. Vanpoulle, Vignac

http://dx.doi.org/10.1016/j.ssci.2017.07.011

and Soule contribute insights on accidentology of mountain sports drawing on the systematic modeling of accident and near-miss sequences. Pomeroy and Earthy discuss learning from incidents within the context of merchant shipping, while Moura, Beer, Patelli and Lewis focus on the graphical representation and analysis of multi-attribute events to enhance risk communication in learning from major accidents. Each of these is described in more detail next.

Walker (Redefining the incidents to learn from: safety science insights acquired on the journey from black boxes to flight data monitoring) argues that flight data could be used in a proactive manner to prevent incidents. Rather than only using the data to analyse incidents that have already happened (lagging indicators), flight data could be used to analyse systems as they drift away from operational norms (leading indicators). Walker recounts the 60 years of development of the Flight Data Recorder, from the early analogue devices up to contemporary solid-state digital audio and video technology. The irony is that aviation accidents are so rare that most black boxes are never used for the purposes they were intended. Walker proposes that this technology could be repurposed to provide data on positive performance indicators. He contrasts the relative values of leading and lagging indicators, to suggest that the former is more useful than the latter. Routine collection of data from everyday flights provides aviation organisations with a wealth of data about normal operations and variability therein. Walker illustrates the usefulness of these data, showing a surprising number of deviances in normal operations. The Flight Data Monitoring Cycle use these data to improve safety (such as changes to operations, manuals, procedures and training) rather than punish those involved. The benefit of this approach is that it capitalises on data that are routinely collected and puts it to use for the benefit of the broader aviation system. This is an approach that could be applied more widely in Safety Management Systems across many domains.

Plant and Stanton (The development of the schema-action-world (SAW) taxonomy for understanding decision making in aeronautical critical incidents) sought to embellish the schema-action-world taxonomy (from the Perceptual Cycle Model – PCM) to enhance the fidelity with which critical incidents could be investigated. A taxonomy is a classification which has mutually exclusive and exhaustive categories if it is to be both reliable and valid. As Plant and Stanton point out, taxonomies are an established approach within accident and incident investigation. They have been used to good effect in the past. Previous research by the authors has shown that the PCM can be applied to both individual and team performance. In this paper, they extend the approach to develop sub-categories for the three main parts of the PCM. They used both inductive and deductive thematic analysis to identify schema (6), action (11) and world (11) sub-categories. The schema taxonomy comprised: vicarious past experience, direct past experience, trained past experience, declarative schema, analogical schema and insufficient schema. The action taxonomy comprised: aviate, navigate, communicate, system management, system monitoring, concurrent diagnostics, decision action, situation assessment, non-action and SOP (Standard Operating Procedure). The world taxonomy comprised: natural environment, technological conditions, communicated information, location, artifacts, display indications, operational context, aircraft status, severity of problem, physical cues, and absent information. Plant and Stanton showed how each of the concepts in the taxonomies contribute to different phases of an incident. They also classified the concepts into three types (i.e., primary, secondary and tertiary) to show the relative contribution of each to the incident. The SAW sub-category taxonomy enables a more detailed examination of critical incidents than the basic taxonomy. Plant and Stanton argue that the taxonomy could be used outside aviation with a few minor changes to some of the sub-categories.

Vanpoulle, Vignac and Soule (Accidentology of mountain sports: An insight provided by the systematic modeling of accident and near-miss sequences) argue that increased numbers of people participating in outdoor sports has led to a commensurate rise in accidents. This has, in turn, led to greater pressure on the need to a better understanding of the cause and consequences of those accidents. They propose a systemic approach to accident causation that takes the entire sociotechnical system into account. Vanpoulle et al argue that this is currently no accepted method for analysing accident causation in mountain sports as most of the methods available were originally developed for the safety critical process and nuclear industries. Also, most accounts of accidents in mountain sports tend to be in the form of narratives and they are usually unstructured and unsystematic. Vanpoulle et al analysed over 600 reports, classifying the contributory factors into one of four categories: environment, equipment, group resources and dynamics, and behavioural events. They used the 'bow-tie' method to link fault trees to event tress, so that barriers to safety could be identified. Vanpoulle et al reported that most of the incidents they analyses resulted from multiple causes, such as: environment, fatigue, exhaustion, lack of equipment, lack of experience, distraction and summit fever (the compulsion to reach the summit at all costs). They explain that their work was exploratory in nature and is based solely on accidents that have already been reported. Nevertheless, the analysis provides a useful framework to understand the accidents and much can be learnt from near misses.

Pomeroy and Earthy (Merchant shipping's reliance on learning from incidents – A habit that needs to change for a challenging future) argue that learning from accidents has become unacceptable in the maritime industry due to the substantial societal, environmental and financial costs involved. Although the annual loss rate for merchant ships has reduced substantially over the past century, losses still occur. Perhaps the most infamous loss was that of RMS Titanic (15 April 1912) that sank on her maiden voyage from Southampton to New York after colliding with an iceberg. Numerous lessons were learnt, including: provision of sufficient lifeboats, radio operation around the clock, international ice patrols, as well as design changes to ship structures. Yet over a century later, the maritime industry is still learning, as Pomeroy and Earthy illustrate in their analysis. Examples are numerous and include: new fire regulations, design of fracture resistant steel, new pollution regulations, inert gas systems for oil tankers, new technical specifications for steering gear, flood warning systems, buoyancy systems, strengthened bulkheads, bow door alarms and indicators, double hull construction, improved firefighting, automated emergency position indicators, Voyage Data Recorders and a new international safety management code (to name but a few). Whilst these measures have undoubtedly improved maritime safety, they are all the direct result of accidents. Pomeroy and Earthy argue that the changes are introduced too late and that a more proactive approach is required. Echoing the points made by others in this special issue, there is a general call for learning from normal behaviour: leading, rather than lagging, indicators enable lessons to be learnt before they become incidents and accidents.

Moura, Beer, Patelli and Lewis (Learning from major accidents: Graphical representation and analysis of multi-attribute events to enhance risk communication) tackle the controversy surrounding the term 'human error', which is the subject of much debate in the contemporary Human Factors literature. Much of this debate stems from the use of the term 'human error' as a terminator in incident investigation. Typically, investigations stop when someone has been found to blame, admonish, and penalise. This could lead to the assumption that the system is safer if the person who erred is no longer in the position (called the 'bad apple' theory). James Reason, in his original definition of 'human error', pointed out that 'human error' was the result of a system that permitted activities that subsequently, that is with the benefit of hindsight, turn out to be erroneous. It is clear that this definition places the fault on the system (such as its poor design, poor training, poor work scheduling, poor operational process, poor maintenance, and so on) and not the person who happened to be working in the system at the time of the incident. The term 'human error' has been so abused over the decades that some are calling for it to be abandoned altogether. Moura et al argue that a new graphical representational format using a multi-attribute technological accidents database would provide a more systematic way of interpreting causality of incidents. Their neural network analysis